



# Performing Corneal Collagen Cross-linking after Radial Keratotomy in a Patient with Keratoconus: Case Report

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## Abstract

To present a case with progressive keratoconus after treated with radial keratotomy (RK) and was undergone corneal collagen cross-linking (CXL) for preventing the progress of keratectasia.

A progressive keratoconus case who was previously treated with RK was undergone corneal collagen cross-linking (CXL) in her left eye for preventing the progress of keratectasia. After the CXL procedure performed at another clinic, best-corrected visual acuity (BCVA) of her left eye decreased from 0.9 to 0.6 Snellen lines in an 8-months follow-up. Pre CXL maximum keratometric power (P-Kmax) was also increased from 52.1 to 57.16 Diopter (D) in the eight months after CXL.

Applying CXL on the keratoconic patient previously treated with RK should be questioned.

**Keywords:** Corneal cross-linking, radial keratotomy, keratoconus.

## Introduction

Keratoconus (KC) is a noninflammatory, usually bilateral corneal disease with a cone-shaped corneal protrusion, apical thinning, and irregular astigmatism and is associated with central scarring at the cornea (1, 2). Radial keratotomy (RK) was a crucial procedure in the history of refractive surgery and was the basic method used to treat patients with mild to moderate myopia (3). A long-term follow-up of patients treated with RK has shown corneal instability and frequent hyperopic shifts, yet corneal ectasia after RK is an uncommon complication (4–7). Moreover, RK was used for treating keratoconic patients, and frequently unfavorable results were observed for treating keratoconic patients with RK in the literature (8–10). Corneal collagen cross-linking (CXL) is a new method for preventing the progress of keratectasia, such as keratoconus and secondary corneal ectasias (6). We

present a case with progressive keratoconus after treating with RK and undergoing CXL to prevent the progress of keratectasia.

## Case Report

A 28-year-old woman was presented to the Department of Ophthalmology at the Gazi University Hospital. She had experienced progressive visual impairment in the left eye for eight months. The patient reported a history of bilateral keratoconus treated with RK at another center eight years previously, and her visual impairment had progressed, particularly in her left eye for the last two years after the RK procedure. Therefore, the patient was diagnosed as having a progression of keratectasia and had undergone the CXL procedure in her left eye to prevent the progress of keratectasia at another clinic. According to the patient's previous doctor, the standard CXL procedure with a hypotonic riboflavin so-

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lution was applied to the patient. Her pre- and post-CXL refractive errors and best-corrected distance visual acuity values (BCVA) are shown in Table 1. Her slit-lamp examination revealed eight well-healed RK scars in the right eye, nearly at 90% corneal thickness, and 10 similar incisions in the left eye of two had separated wound lips in the temporal part (Figs. 1a, 2a, b). Her intraocular pressure (IOP) measured by Goldmann applanation tonometry was 12 mm Hg in both eyes and her fundus examination was normal.

Pre-CXL scanning-computerized (Orbscan, Bausch & Lomb USA) corneal topography revealed inferior corneal ectasia with corneal astigmatism of 0.50 D in the right eye. The thinnest point pachymetry of the right eye was 397µ and the maximum keratometric power (P-Kmax) was 50.1 diopter (D) (Fig. 1a) (Table 2). In the pre-CXL corneal topography of the left eye, an inferotemporal corneal ectasia and corneal astigmatism of 3.5 D was observed. The thinnest point pachymetry of the left eye was 382µ, and the maximum keratometric power (P-Kmax) was 52.1 D (Fig. 1b) (Table 2). In the 8<sup>th</sup> month after CXL scanning, computerized corneal topography (Sirius 3D Rotating Scheimpflug Camera–Topography System Costruzione Strumenti Of talmici,

Florence, Italy) exhibited inferior corneal ectasia with corneal astigmatism of 0.75 D in the right eye. The thinnest point pachymetry of the right eye was 425µ, and P-Kmax was 51.1 D (Table 2). These values were similar to that of pre-CXL corneal topography (Fig. 2b). However, there was a progress of inferotemporal corneal ectasia matching with separated wound lips in the slit lamp examination in the corneal topography of the left eye (Fig. 3a, b). Even though the thinnest point pachymetry of the left eye was similar to the pre-CXL value (395µ), the increase of P-Kmax (57.16 D) was remarkable (Fig. 3c) (Table 2). Additionally, the anterior segment optic coherence tomography (AS-OCT) shows the separated wound lips (Fig. 3d, e).

**Discussion**

The RK method used to treat mild to moderate myopia caused a hyperopic shift, exacerbated corneal ectasia and corneal instability in the long-term and was abandoned in the early 1990s (3). Even though Utine et al. (11) presented that RK surgery was a reasonable option for the rehabilitation of keratoconic corneas in the early or moderate stages, there were frequently unfavorable results for treating keratoconic

**Table 1.** Refractive errors – best corrected distance visual acuity values

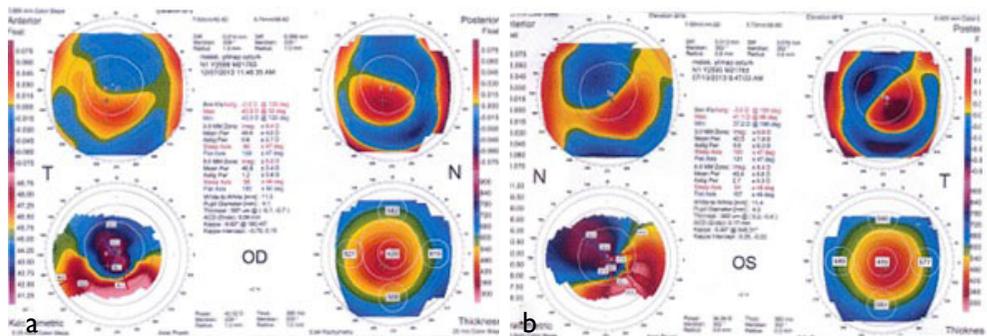
Eye	Pre – CXL RE	Post – CXL RE	Pre – CXL BCVA	Post – CXL BCVA
Right	-1.50D sp -2.00D cyl	-3.00 sp -1.50D cyl	0.9 Snellen	0.9 Snellen
Left	-0.50D sp -2.00D cyl	+1.00 sp -2.50D cyl	0.9 Snellen	0.6* Snellen

CXL: corneal collagen crosslinking; RE: refractive error; BCVA: best-corrected visual acuity values; D: diopters  
\*no improvement with refraction.

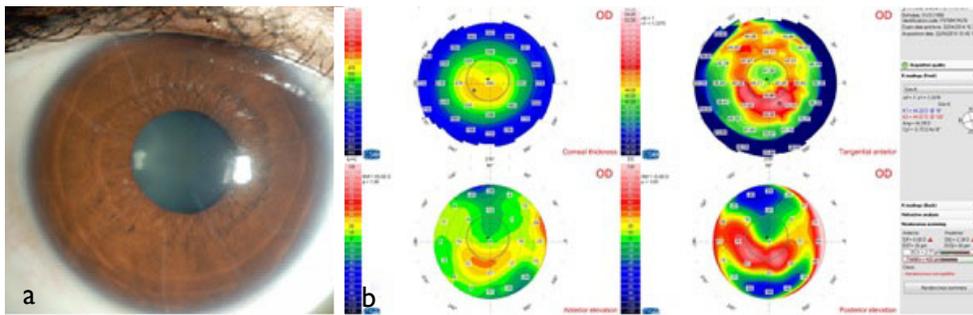
**Table 2.** Computerized corneal topography values

Eye	Pre – CXL Kmax	Post – CXL Kmax	Pre – CXL TP	Post – CXL TP
Right	50.1 D	51.1 D	397 µ	425 µ
Left	52.1 D	57.16 D	382 µ	395 µ

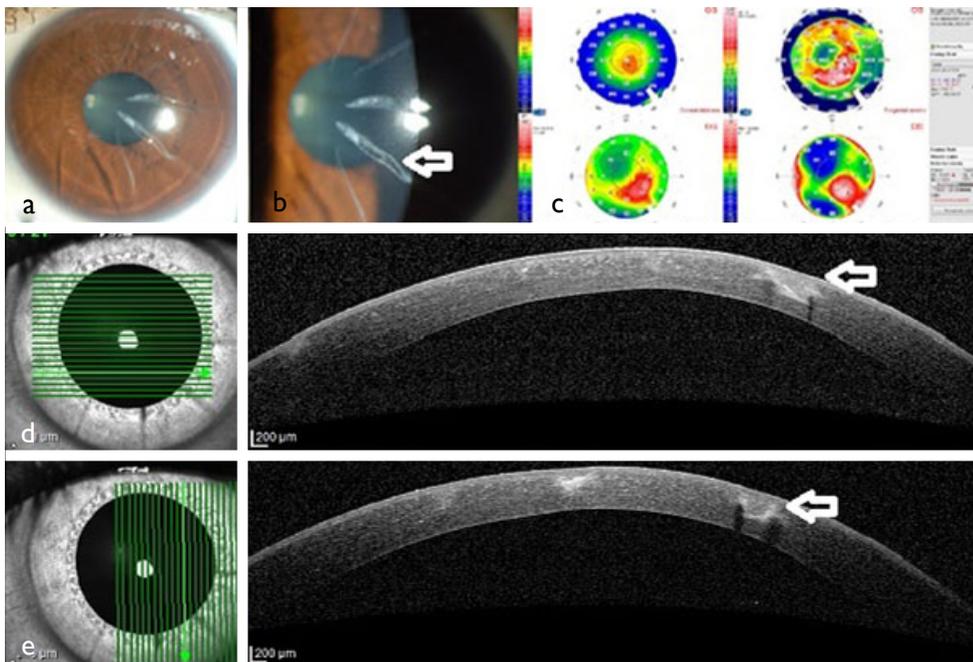
CXL: corneal collagen crosslinking; TP: thinnest point pachymetry; Kmax: maximum keratometric power; D: diopters.



**Figure 1.** (a) Corneal Topography of right eye (b) Pre-CXL Corneal Topography of the left eye.



**Figure 2.** (a) Eight well-healed RK scars in the right eye (b) Corneal Topography of right eye.



**Figure 3.** (a) 10 RK incisions in the left eye (b) 2 RK incisions had separated wound lips in temporal part (white arrow) (c) corneal topography of the left eye: progress of inferotemporal corneal ectasia matching with separated wound lips (d, e) AS-OCT shows the separated wound lips.

patients with RK in the literature, (4-6, 9) and exacerbation of corneal ectasia was particularly reported as a complication since biomechanical instability is a crucial component of KC. Thus, RK-induced corneal weakening and biomechanical instability could be responsible for this exacerbation (7, 12). Laser in situ keratomileusis (LASIK), photorefractive keratectomy, double-concentric corneal sutures and implantable collamer lens were reported strategies for managing post-RK refractive errors. However, the reported results are variable and unpredictable. The long-term stability is controversial (13-16). CXL was shown to be effective and safe for preventing the progress of keratectasia in keratoconic corneas and corneal ectasias that arose from the LASIK procedure. With CXL, there is a mild flattening of the cornea, a decrease of refractive error, and an increase in visual acuity (17). Although there were limited data performing CXL after RK, Elbaz et al. (18) showed that CXL is a safe and effective

method to restore corneal stability in eyes with a history of RK. On the other hand, their patients had no history of keratectasia like the patient described in this report. Furthermore, Mazzotta et al. (6) claimed that CXL is a promising option for managing keratoconic patients previously treated with RK. They hypothesized that CXL stiffened collagen in the anterior and midstroma, increased interlamellar connections, and therefore, the main effect of cross-linking might be on keratoconus. According to their hypothesis, (6) the CXL effect failed to reach the depths of the reach that RK has. The present case report showed that performing CXL on keratoconic patient treated with RK could even accelerate the exacerbation. Similarly, in the literature, (4-6, 9) exacerbated corneal ectasia is a possible complication of RK, particularly in keratoconic corneas. One possible explanation for the acceleration of the keratoconic progression after RK is that the cross-linking of collagen fibers may stretch the

wound lips of RK. Thus, the CXL effect probably does not reach the pathological area, (6) and this may result in new-onset instability.

Although we thought that CXL is the main reason for exacerbation, loosening of the incisional scars could change the corneal topography of the current patient. In the current case report, the pre- and post-CXL corneal topography methods differ, which is an important limiting factor because it may affect the measurements. Thus, we could not provide an answer regarding whether the progression – detected in the eighth month after CXL – was caused by the CXL treatment or whether it was continued progression.

In conclusion, we thought that applying CXL on keratoconic patient previously treated with RK should be questioned. Evaluation of larger series with longer follow-up is needed to provide further information on the potential efficacy of CXL in keratoconic corneas treated with RK.

#### Disclosures

**Informed consent:** Written informed consent was obtained from the patient for the publication of the case report and the accompanying images.

**Peer-review:** Externally peer-reviewed.

**Conflict of Interest:** None declared.

**Authorship Contributions:** Involved in design and conduct of the study (MOC, KB); preparation and review of the study (MOC, KB); data collection (MOC, KB).

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